Vista Gold Australia

Discharge Plan

Revision 2

October 2014

Executive Summary

This Discharge Plan has been developed for Vista Gold Australia Pty Ltd (Vista Gold) to address the requirements of Waste Discharge Licence (WDL) 178-4. This Discharge Plan describes the investigations that have been, and are proposed to be, conducted in a weight of evidence approach (using multiple lines of evidence) to derive dilution factors for mine waste water discharge from site. The dilution factors have been calculated for ecosystem protection in the Edith River at the 80% species protection level near the point of discharge (SW4) and were derived from ecotoxicity testing using appropriate species following ANZECC (2000) guidelines. Investigations used to derive the 2014/2015 dilution factors and provide additional information on the health of the Edith River downstream from the discharge point include:

- Investigations into the toxicity of Retention Pond (RP) 7 mine water.
- Investigations into the toxicity of treated RP3 mine water (pilot trial and in-situ samples).
- Investigations into the toxicity of RP1 mine water.
- Investigations into the toxicity of Crocodile Gold Australia Operations mine water.
- Risk assessment for the discharge of treated RP3 mine water at SW4.
- Investigations into the determination of a mixing zone for the Mt Todd discharge.
- Macroinvertebrate and sediment studies to assess downstream impacts from the mine discharge.
- Investigations into the speciation of metals due to water chemistry at the site.

This Discharge Plan provides results to date for the investigations listed above to address the requirements of WDL 178-4.

This Discharge Plan provides information that will be used by Vista Gold for guidance on ecosystem protection within the Edith River including:

- An 80 percent species protection dilution factor obtained from 18 suites of site specific bioassays using DTA methodology that can be applied to discharges of treated RP3, untreated RP1 and untreated RP7.

This Discharge Plan also provides the outcomes of a risk assessment on water quality of RP3 discharges on the Edith River. A risk assessment conducted on the water quality for the February 2014 discharge from RP3 using the site specific trigger values (SSTVs) (based on 80 percent species protection trigger values) showed that that copper and pH pose a low risk to the aquatic ecosystem of Edith River at the monitoring site SW4 during discharge events. However, a longer term data set (water quality measured between November 2011 and April 2014) indicates that risk levels are low to nil at SW4. Scores were assigned conservatively, taking into account the most sensitive biota such as microalgae and macroinvertebrates.

Abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
ARD	Acid rock drainage
DOC	Dissolved organic carbon
DTA	Direct toxicity assessment
ERISS	Environmental Research Institute of the Supervising Scientist
L	Litre
Kg	Kilogram
µg	Microgram
µS/cm	Microsiemens/centimetre
mg	Milligram
NATA	National Association of Testing Authorities
NT EPA	Northern Territory Environment Protection Authority
NRETAS	Department of Natural Resources, Environment, The Arts and Sport
NT	Northern Territory
%ile	Percentile
mm	Millimetre
OECD	Organisation for Economic Co-operation and Development
RP	Retention pond
SSD	Species sensitivity distribution
SSTV	Site specific trigger value
TOC	Total organic carbon
TV	Trigger value
USEPA	United States of America Environmental Protection Authority
WDL	Waste Discharge Licence

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1. Introduction

1.1 Project Background

Vista Gold Australia Pty Ltd (Vista Gold) received a Waste Discharge Licence (WDL 178-3) in November 2013 from the Northern Territory Environment Protection Authority (NT EPA) (Appendix A). The WDL outlines requirements for environmental protection of the Edith River from mine wastewater discharges from the Mt Todd mine site. This WDL expired on 30 September 2014, and several conditions within WDL 178-3 are no longer applicable to the management of discharge water at the Mt Todd site, due to amount of information obtained from scientific studies conducted over the last few years.

This Discharge Plan has been developed to be used in conjunction with the relevant sections of the WDL, in order to manage and minimise environmental impacts of the Mt Todd discharge.

Management of and responsibility for the various aspects of MT Todd is currently subject to an agreement between Vista Gold and the NT Department of Mines and Energy (DME). The agreement identifies Vista Gold as the onsite operator, responsible for maintaining the site assets of the Northern Territory Government, including daily management of the site and ensuring there is no further degradation of the environmental legacy issues at the site. The NT Government is responsible for the legacy environmental liability, which includes the onsite acid rock drainage (ARD) water inventory, until production at the site is resumed.

In 2014 and subsequent years, onsite wet season management of ARD waters will be undertaken by Vista Gold and funded by both organisations.

1.2 Water Treatment Objectives

The treatment and discharge of RP3 water will allow the DME to meet their objectives at the Mt Todd site. These objectives are:

- To reduce the on-site water inventory.
- To reduce the risk of an uncontrolled discharge from RP1, RP7 and RP3.

To meet the water inventory objectives, treated water from RP3 is proposed to be discharged to Batman Creek after which it will enter the Edith River via Stow Creek. The chemistry of the RP3 water, the flow in the Edith River and the capacity of the pumps will determine the amount of water able to be discharged to meet the ANZECC (2000) 80 percent species protection trigger values at SW4.

1.2.1 Proposed Discharge Management

Due to the potential for rapidly changing water quality in RP3, the use of a DTA result obtained from samples collected at the end of the dry season to calculate a 2014/2015 wet season dilution has several operational limitations.

The application of additional water treatment in RP3 during late 2014 will result in improved water quality in the pit. The use of a dry season DTA result for calculating the dilution factor for RP3 will be overly-conservative and severely limit the amount of water able to be pumped out of the pit. Depending on the onsite water management actions, pumping untreated water from RP1 or RP7 into RP3 will also change the water chemistry in RP3, likely resulting in poorer water quality. Therefore, the use of a single DTA at the end of the 2014 dry season will not provide an ongoing accurate indication of the dilution required to meet the trigger values at SW4.

Also, conducting DTAs each time the water chemistry changes will not provide useful results as:

1. The water chemistry in RP3 may change on a daily basis (due to treatment, rainfall and possible inputs from RP1 and/or RP7);
2. DTA results from the laboratory may take up to 8 weeks and not be applicable to the current water quality.

Vista Gold is proposing to discharge only from RP3, if possible, with RP1 and RP7 water pumped to RP3 during the wet season if required. However, controlled discharge for the following scenarios in addition to the routine discharge from RP3 may be required in exceptional circumstances which override normal onsite water management actions:

- Controlled discharge from RP1
- Controlled discharge from RP7
- Controlled discharge from RP1 and RP7

The controlled release of water in the above scenarios would only be undertaken for the following reasons:

1. When there is a significant risk to the integrity of the retention pond structure, and lowering of the internal water level will contribute to a reduction in the risk of failure
2. When there is a significant risk of an uncontrolled discharge and lowering of the internal water levels will reduce the risk of uncontrolled discharge or minimise the quantity of uncontrolled discharge

1.2.2 Toxicity assessment

Vista Gold has already treated the water in RP3 to reduce the metal concentrations in the water to be discharged and DME are proposing to further treat the RP3 water in late 2014. Vista Gold intends to continue managing the environmental impacts from the mine discharge to the Edith River by meeting 80 percent species protection site specific trigger values at the downstream site SW4 as permitted in WDL 178-3.

WDL 178-3 required the use of dilution factors calculated from direct toxicity assessment (DTA) of each RP, and the 80 percent species protection factor was then calculated from the results. Monitoring values for specific metals were calculated to be applied at sampling point SW4 for the 2013/2014 wet season.

Vista Gold now has sufficient ecotoxicology and chemistry data to calculate the predicted toxicity of discharge water based on the current water chemistry, and thus to determine the dilution factor required to meet selected 80 percent trigger values downstream at SW4.

Vista Gold will calculate the volumes to be discharged from RP3 using an algorithm for the dilution factor, based on the chemistry at the time of discharge and the previous DTA results from both Vista Gold and Crocodile Gold discharges. The dilution will be managed by in-situ telemetry based on Edith River flows, which will determine the volume of treated RP3 water to be released.

1.3 Scope of Work

This Discharge Plan addresses the following aspects of the WDL:

- Proposed water management strategy for the Mt Todd mine site discharge.
- Methodology for the application of the 80 percent species protection site specific trigger values following ANZECC (2000) guidelines for ecosystem protection applied at SW4 for mine discharges from RP3, RP1 and RP7.

- Methodology for the application of an algorithm to calculate the dilution factor required for each RP based on the current water quality and up-to-date DTA data.
- Investigation procedures triggered by an exceedence of the dilution factor at SW4.
- Validation of the mixing zone model using ecotoxicological methodology and determination of the environmental impact outside the mixing zone i.e. no chronic toxicity observed outside the mixing zone. (*To be completed following receipt of sufficient discharge and water quality data and ecotoxicity testing to enable validation.)*
- Biological assessment methodology (i.e. macroinvertebrate population studies) and sediment studies to aid in the assessment of downstream impacts and validation of trigger values.
- Development and completion of a risk assessment matrix that can be used to determine the risk posed by an exceedence of an 80% species protection dilution factor at SW4.

1.4 Limitations

This Vista Gold Australia Discharge Plan 2014 ("Report"):

1. *has been prepared by GHD Australia Pty Ltd ("GHD") for Vista Gold Australia Pty Ltd (Vista Gold) and the NT EPA;*
2. *may only be used and relied on by Vista Gold and the NT EPA;*
3. *must not be copied to, used by, or relied on by any person other than Vista Gold without the prior written consent of GHD;*
4. *may only be used for the purpose of addressing WDL requirements (and must not be used for any other purpose).*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Vista Gold arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- *were limited to those specifically detailed in section 1.4 of this Report*

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- *Current accepted practices*

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 6 months, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

The Envirotech 2013-2014 Macroinvertebrate and Sediment Monitoring Report located in Appendix F has not been peer reviewed by GHD. Any conclusions listed in this report are those of Envirotech Monitoring and are not necessarily conclusions adopted by GHD.

2. Discharge Management Strategy

2.1 Introduction

As discussed in Section 1, Vista Gold will to use this Discharge Plan in conjunction with the WDL to enable the discharge of water from the Mt Todd mine site to meet NT EPA environmental requirements and DME objectives. The Water Management Plan (Section 6) in the Mount Todd Gold Project Mining Management Plan 2013-2017 (Vista Gold MMP 2013) discusses all details in relation to onsite surface waters, infrastructure and management. This Section of the Discharge Plan discusses the discharge management strategy only.

2.2 Water Pumping and Release Strategy

Vista Gold are intending to release water from RP3 only during the 2014/2015 wet season, however during unforeseen circumstances, discharges from RP1 and/or RP7 may be required, either individually or as part of a multisource discharge.

To manage the volumes in RP1 and RP7, Vista Gold are proposing to pump treated and non-treated water from both RPs to RP3 for discharge. Table 1 outlines the water management for the RPs involved in this Discharge Plan. Additional information on the water management of other RPs at Mt Todd is available in Vista Gold MMP (2013).

Table 1 Water Transfers and Monotoring Procedures (*MMP Vista Gold 2013*)

Water Transfers	Monitoring
RP1	
Maintain freeboard by pumping untreated water to RP7 or treat water via WTP and redirect to RP3. October to February – pump if freeboard is less than 2.5 metres. March to April – pump if freeboard is less than 1 metre. Dry season – pump if major rainfall is expected and freeboard is less than 0.5 metres. Discharge to Edith River through siphons when licence conditions can be met, and when no other discharges are occurring to the Edith River. April to November – maximise evaporation opportunities.	RP1 level daily (during wet). Flow to RP3 (cumulative and instantaneous. Daily recording of WTP flow meter and pump operating times). Discharge to Edith River through siphon (cumulative and instantaneous. Daily recording of flow meter and siphon operating times). Pump infrastructure (weekly). Water quality monitoring as per WDL.
RP3	
Siphon, if possible, to Batman Creek when licence conditions and Edith River dilution rates can be met and no other discharges are occurring to the Edith River from any other source. Pump top Batman Creek when licence conditions and Edith River dilution rates can be met and authorisation is obtained from the General Manager to commit to the associated expenditure. RP3 can receive excess water from RP1, RP2 and the heap leach moat via the WTP as treated water.	RP3 level (daily during wet). Flow (cumulative and instantaneous. Daily flow meter recording and siphon or pump operating times). Pump infrastructure weekly. Water quality monitoring as per WDL.

Water Transfers	Monitoring
RP7	
October to March – Discharge to Horseshoe Creek via decant ponds when licence conditions can be met ie. no other discharges occurring to the Edith River from any other source and freeboard is less than 1.0 m from the base of spillway plug. October to March – Pump untreated water to RP3 when water level is at base of spillway. Redirect all pumped inputs to RP3. April to November – maximise evaporation opportunities. Receives water from RP5 and HLP when WTP is in use.	RP7 level (weekly). Flow to RP3 (cumulative and based on pump operating times) Pump infrastructure (weekly). Water quality monitoring as per WDL

Figure 1 shows the water movement and discharge locations for each RP at the Mt Todd site.

2.3 Monitoring of RP3

Vista Gold intends to monitor the water quality in RP3 on a daily basis during discharge from the start of the 2014/2015 wet season. Vista Gold will send a water sample to North Australian Laboratories located at Pine Creek , which is able to provide chemistry results the same day. The results will be used by Vista Gold to calculate the dilution factor for the RP3 discharge. The dilution factor will then be programmed into the telemetry system as described in Section 4. These results will be confirmed upon receipt of the same sample analysed by a NATA accredited laboratory.

2.4 Monitoring of SW4

Monitoring at SW4 will be conducted daily during discharge to meet the requirements of the WDL. Sub-samples will be sent to the Pine Creek laboratory to determine that SSTVs are being met. The results of the samples will be validated, upon receipt of results from the NATA accredited laboratory. By using the local laboratory, results will be received on the same day and any exceedences of the SSTVs can be managed immediately and dilution factors recalculated.

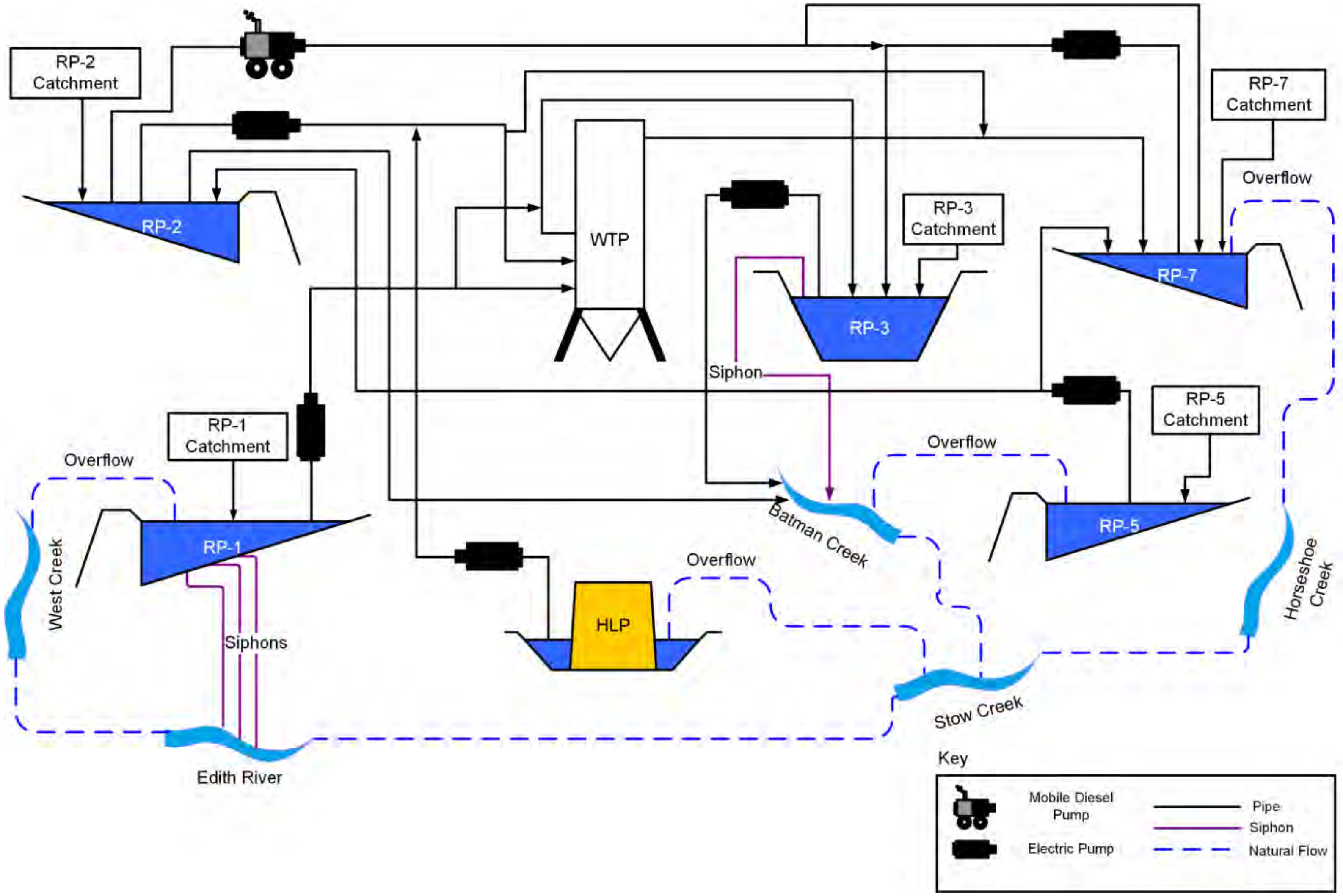

Figure 1 Mt Todd Mine Water Management Conceptual Site Model

3. Site Specific Trigger Values for the Edith River

3.1 Trigger Values

This Discharge Plan has been designed to enable calculation of the dilution factors from direct toxicity assessments (DTA) previously conducted on RP1, RP3, RP7 and various Crocodile Gold sites. These dilution factors, in combination with site specific trigger values (SSTVs), are to be used in managing environmental impacts from Mt Todd mine site discharges. This approach using DTA is preferred for environmental management of a complex effluent (ANZECC 2000).

This Section discusses the derivation and application of the 2014/2015 SSTVs derived for Mt Todd mine site and the Edith River at the 80 percent species protection level. The SSTVs were derived from:

- Edith River water quality.
- Upstream Stow Creek water quality.
- The ANZECC (2000) default trigger values.
- Current literature following the methodology in GHD (2011).

Trigger values are used to provide an initial assessment of the state of a water body and, if exceeded, will trigger further investigation and/or a management/remedial response.

3.2 Method

The methodology used to derive SSTVs for Vista Gold's Mt Todd Mine for the wet season 2014/2015 follows the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) and the methods outlined in GHD (2011). The ANZECC (2000) guidelines form part of Australia's National Water Quality Management Strategy. The primary objective of the guidelines is "*to provide an authoritative guide for setting water quality objectives required to sustain current or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand*".

The document specifically states that the ANZECC (2000) Guidelines "*are not meant to be applied directly to recycled water quality, contaminant levels in discharges from industry, mixing zones, or stormwater quality*". Instead, they should be applied to waters outside of these areas, with consideration given to the system inputs, including type and condition, as discussed in the SSTV Plan (GHD 2011).

Trigger values are an early warning mechanism to provide insight into potential adverse water quality changes. They are not intended to be an instrument to assess 'compliance' and should not be used in this capacity (Appendix 7, ANZECC 2000). Trigger values are designed for environmental protection and are to be met at the edge of the mixing zone.

The SSTVs calculated in this document are to be applied to the Edith River downstream monitoring point SW4.

3.2.1 Need for Trigger Values

Discharge from mining activities potentially contains a range of compounds and elements that could have a detrimental impact on the receiving environment. Once the concentrations of each of these chemicals are known, it is necessary to assess their impact by comparing them to relevant trigger values for ecosystem protection. Trigger values may be derived from:

- ANZECC (2000) default values

- Licence limits
- Site specific values
- Local ecotoxicity testing.

The ANZECC (2000) Guidelines define trigger values as:

"… the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions." (ANZECC 2000, Volume 1, Appendix 1).

3.3 Sites used for SSTV Calculation

The Edith River receives water from a catchment of 671 km^2 at the gauging station located downstream of the mine. Several tributaries of the Edith River cross or come in close proximity to the mine site. Horseshoe Creek and Batman Creek traverse the site before entering Stow Creek, which runs directly into the Edith River. West Creek and Burrel Creek are located in the south west of the site and also enter directly into the Edith River.

Stow Creek enters Edith River upstream of the WDL monitoring point SW4, and will impact on water quality at the mine lease boundary. Therefore, upstream sites that are applicable for use as background water quality are:

- Stow Creek (SW13)
- Edith River (SW2)

Table 2 Surface Water Monitoring Sites used in this SSTV

	Stow Creek Upstream	Edith River Upstream	Edith River Downstream
Site	SW13	SW2	SW4
Latitude	-14.15605208	-14.17194471	-14.1703
Longitude	132.129894	132.1198981	132.098

3.4 Data provided by Vista Gold

Vista Gold has provided water quality data for the three sites listed in Table 2, obtained from the Surface Water Monitoring Program. The three locations are shown in Figure 2.

The data from the sites shown in this document are representative of the background environment of Edith River. Upstream and downstream conditions on the river system have been used to establish baseline water quality and current environmental conditions at these locations. A summary of the water quality data is presented in Appendix B.

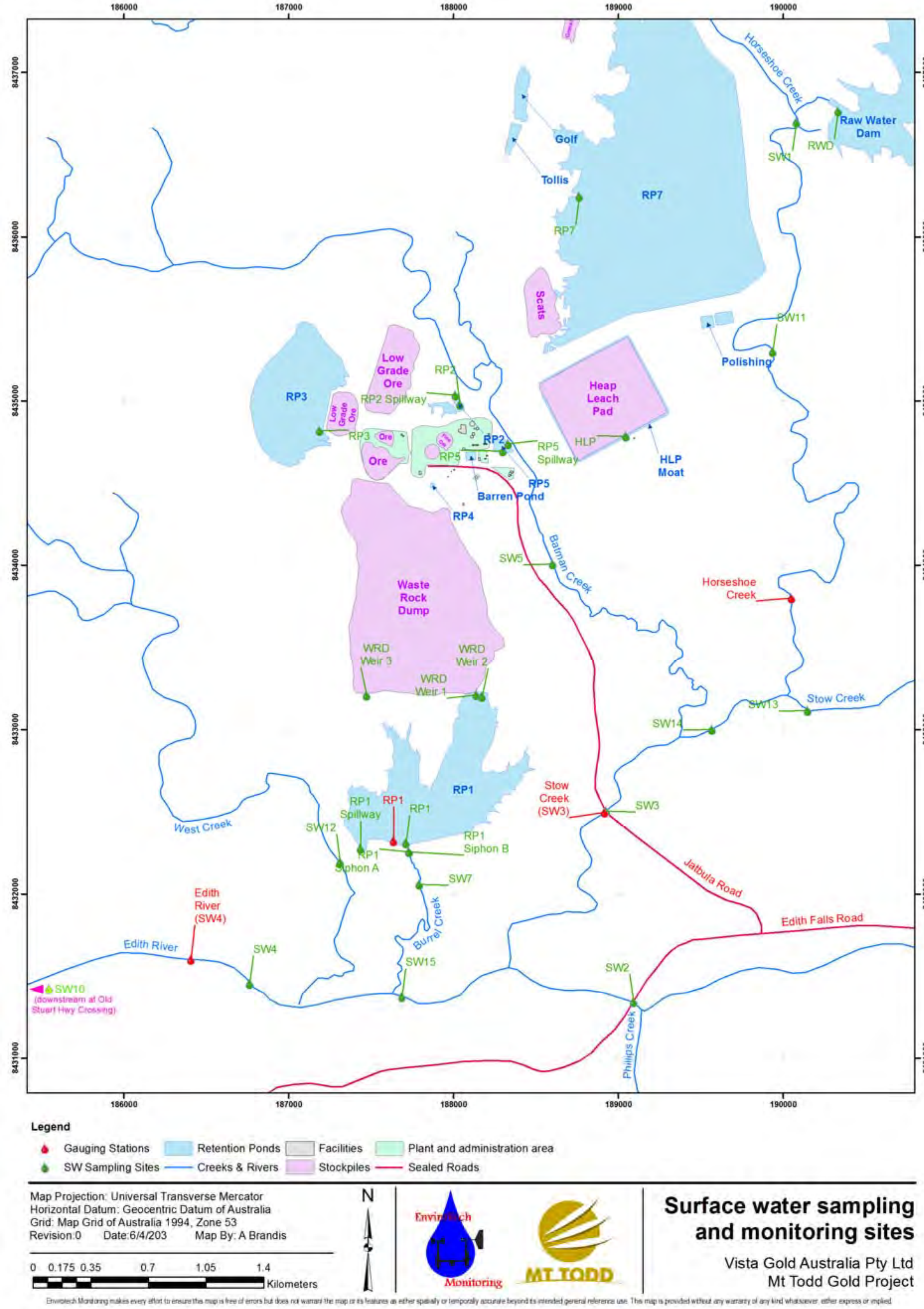

Figure 2 Mt Todd Mine Monitoring Locations Map

Beneficial Uses

The highly disturbed category has been applied to Edith River, which requires an 80 percent species protection level in order to allow the Beneficial Uses of the Edith River to be achieved downstream of the mine site. The declared beneficial use for surface water in the Edith River catchment, including the mine site and the Edith River up and downstream of the site, is the protection of aquatic ecosystems under the *Water Act* (1992); however agriculture does occur downstream of the mine site, and Edith River water may be used for irrigation or stock watering.

The aquatic ecosystems generally represent the most sensitive aspect of catchment health, so water quality trigger values appropriately default to these values where they are available. Where guideline triggers are unavailable and site-specific triggers cannot be determined, it is appropriate to use a guideline based on the next most sensitive values.

3.5 Aquatic Ecosystem Trigger Values

3.5.1 Derivation of Site Specific Trigger Values

The SSTVs in this Report have been derived on the basis of the ANZECC (2000) Guidelines procedure and GHD (2011) Site Specific Trigger Value Plan. The process has been to calculate a series of different percentiles for different parameters as follows:

- For physicochemical parameters: 20^{th} and/or 80^{th} percentile of upstream
- For nutrients and non-toxic compounds: 80^{th} percentile of upstream
- For metals: 80^{th} percentile of upstream

Then compare the:

- ANZECC (2000) default trigger values for freshwater ecosystems and toxicants in freshwaters.
- Reliable background level (80^{th} percentile) of parameters at the chosen reference sites.
- The reference site chosen to derive the site specific trigger values, SW2, is located upstream from the mine discharge on Edith River and SW13 located on Stow Creek as shown in Figure 2.

The highest value is selected as the trigger value, although for metals, if the background conditions are equal to or higher than the published trigger value or when no trigger value exists, then the 80^{th} percentile of the data set has been be adopted as the trigger value (ANZECC (2000), Section 8.3.5.5, Volume 2).

3.5.2 Data Requirements: Chemicals and Seasonal Variation

A good understanding of the ambient water quality and seasonal variations is a critical part of any environmental assessment study. The background data collected has included each chemical that may be present in the discharge water and may enter the environment. This is of particular importance when natural background concentrations of these chemicals are high as may be the case in mineralised mining environments. In this case the water quality data includes all the analytes listed in *Appendix 1 Surface Water Monitoring Program* of the WDL 178-3.

The ANZECC Guidelines (2000) recommend that, for the purpose of deriving ambient values and site specific trigger values, a sufficient amount of data needs to be collected and that it should characterise seasonal variations:

"A minimum of two years of continuous monthly data at the reference site is required before a valid trigger value can be established. " (Volume 1, Section 7.4.4.1).

The guidelines recommend the use of filtered (or dissolved) samples as a conservative approach to estimating the concentration of the indicator. This allows for better estimation of the presence of metals in their bioavailable form (ANZECC Section 7.4.2).

Background Data

The background data from SW2 used for calculating the SSTVs dates from November 2011 during wet and dry season flows. The data exceeds the 24 month data requirements of ANZECC (2000), and provides a good indication of the variability of water quality in the river during the wet season. These data are of sufficient quality and covers three wet seasons, and have therefore been used to derive SSTVs values for the Mt Todd Mine to be met at sampling point SW4.

The Stow Creek monitoring site (SW13) was added to the Mt Todd 2011 Water Monitoring Plan and was monitored during the 2011/2012, 2012/2013 and 2013/2014 wet seasons. Data gaps are caused by a lack of flow in the creek. No water quality data from this site is available prior to November 2011. SW13 provides information on the water quality entering Edith River upstream of the SW4 monitoring point. Therefore, the water quality from this monitoring point has been included in the calculation of the SSTVs to be applied to SW4.

The SSTVs to be applied to SW4 during the 2014/2015 wet season will include the water quality from SW13. As Stow Creek contributes approximately 30 percent volume to the Edith River during high flows (A. Brandis pers. comm.), the water quality from this site will contribute 25 percent to the SSTV to take into account periods of lower flow. The water quality from SW2 will contribute 75 percent to the SSTV. As there is no flow monitor at SW13, the contribution of Stow Creek to the flow of Edith River is unmeasured. If the flow contribution from Stow Creek to Edith River can be calculated, the contribution to water quality can be established and the SSTVs recalculated accordingly.

The 2014/2015 SSTVs are calculated on the amount of water quality data and site knowledge available to date. The SSTVs will be updated at the end of each wet season to include current water quality data.

For the purposes of deriving SSTVs, parameters of concern were identified from *Appendix 1 Surface Water Monitoring Program* of the WDL 178-3. It should be noted that hardness data is collected for all sites, which has allowed for hardness modification of SSTVs in the event that downstream toxicant concentrations exceed the SSTVs.

ANZECC (2000) default trigger values

For ecosystems that can be classified as highly disturbed, the 95 percent species protection trigger values may still apply. However, it could be appropriate to apply a less stringent guideline trigger value such as 90 or 80 percent protection level. This depends largely on the state of the ecosystem, water management goals and the approval of NT EPA. For developing site specific trigger values for the Mt Todd Mine, in order to not contribute to the disturbed nature of the system and to work towards continual improvement of the system, the protection levels have been set at 80 percent to be met at SW4. The application of the 80 percent protection level at SW4 should allow the 95% species protection level to be met at SW10, with the exception of copper (present at SW10 potentially a product of the December 2011 train derailment).

Within the ANZECC (2000) guidelines, Edith River falls into the lowland river category depending on the parameter reviewed, as outlined in Table 3.

Table 3 ANZECC (2000) Categorisation of Edith River

Parameter	ANZECC Category
Physicochemical	Aquatic Ecosystem Protection, "Lowland Rivers for NT", (ANZECC (2000), Table 8.2.8 to 8.2.12).
Nutrients	Aquatic Ecosystem Protection, "Lowland Rivers of NT", (ANZECC (2000), Tables 8.2.2 to 8.2.7).
Metals and toxicants	"Freshwater" category (ANZECC (2000), Table 3.4.1), with 95 percent species protection for slightly-moderately disturbed ecosystems being considered as appropriate.

High and Low Reliability Trigger Values: High reliability trigger values have been be preferred in this Report as low reliability values are obtained from an incomplete data set[1], however some low reliability values have been used where data is not sufficient to develop site specific trigger values e.g. chromium.

3.5.3 Data Validation

All available data collected to date has been considered in the determination of ambient conditions and the assessment of trigger values. Data used in the calculation of SSTVs for SW4 are located in Appendix B.

The 20th percentiles and 80th percentiles have been calculated for the derivation of site specific trigger values.

3.5.4 Data Below Limit of Reporting

When the analytical result is below the Limit of Reporting (LOR) for a particular chemical species, then a value of half the detection limit has been included in the calculation. This is one of the recommended approaches by the Water Quality Monitoring and Reporting Guidelines (ANZECC (2000), Section 6.2.1). It is also understood that this approach has limitations, in particular when over 25 percent of the data is below the detection limit (BDL). Where greater than 25 percent of values in a background dataset are below the detection limit the ANZECC (2000) default trigger value has been selected as the site specific trigger value (SSTV).

3.5.5 Hardness Modified Trigger Values

The ANZECC (2000) guidelines require the trigger values for several metals to be corrected for hardness to account for the hardness of the local water. The metals which fall in to this category are cadmium, chromium (iii), copper, lead, nickel and zinc. The SSTV has been modified for hardness using the 80th percentile hardness value for the downstream (SW4) monitoring location where required.

[1] For toxicants two types of triggers exist, high reliability trigger values and low reliability trigger values. These are defined as follows:
"High Reliability Trigger Value – Trigger values that have a higher degree of confidence because they are from an adequate set of chronic toxicity data.
Low Reliability Trigger Value – Trigger values that have a low degree of confidence because they are derived from an incomplete data set. They are derived using either assessment factors or from modelled data using statistical method. They should only be used as interim indicative working levels." (ANZECC, Volume 1, Appendix 1).

3.6 2014/2015 Site Specific Trigger Values

3.6.1 Gap Analysis

A gap analysis has been performed on the data provided by Vista Gold for sites SW2 and SW13. The amount of water quality data provided by Vista Gold is shown in Table 4. All the water quality data from 2012 to 2014 for both sites are located in Appendix B. SSTVs are based primarily on data from the upstream monitoring sites SW2 and from SW13.

Table 4 Water Quality Data

Site	Number of Samples (physico-chem)	Number of Samples (Metals)	Dates
SW2	22	23	July 2012 – April 2014
SW13	18	18	December 2011 – April 2014

Table 5 shows the calculated hardness data for site SW4, however because the 80th percentile is in the soft water range, the hardness correction factor as discussed in Section 6.5.5 was not required. The analytes presented in Table 6 are those listed in WDL 178-3 that have trigger values listed in ANZECC (2000).

Table 5 Hardness Data for SW4 (2011 to 2014)

	Hardness ($CaCO_3$) mg/L
Number	21
Minimum	3.0
Median	6.0
Maximum	29
80th Percentile	12

3.6.2 2014/2015 Wet Season Site Specific Trigger Values

From the data shown in Table 6 all analytes have sufficient data to generate site specific trigger values. The data in Table 6 contributes 75 percent to the SSTV and the data in Table 7 contributes 25 percent to the SSTV.

Table 6 Edith River SW2 Statistical Summary (July 2012 to April 2014)

Analyte	N	Min	Median	Max	20th Percentile	80th Percentile
pH	22	5.44	5.83	6.9	5.62	6.60
Electrical Conductivity µS/cm	22	13.9	18.1	27.3	-	25.3
Dissolved Oxygen %	22	7.8	81.2	95.6	69.8	89.7
Total Suspended Solids mg/L	21	<5	-	14	-	<5
Total Dissolved Solids mg/L	21	11	32	150	-	48.8
Total Solids mg/L	14	15	41	81		50
Sulfate mg/L	21	<1	-	2	-	<1
Bicarbonate mg/L	20	<5	8	28	-	12
Alkalinity mg/L	20	<5	8	28	-	12
Hardness mg/L	20	<3	4.5	8.0	-	6.6
Sodium mg/L	20	1.1	1.7	2.1	-	1.8
Chloride mg/L	21	0.5	2	7	-	2
Calcium mg/L	21	<0.5	0.5	1.4	-	<1.0
Total cyanide µg/L	21	BDL	-	-	-	-
Dissolved Metals						
Aluminium µg/L	24	5	5	65	-	30
Cadmium µg/L	24	BDL	-	-	-	-
Cobalt µg/L	24	BDL	-	-	-	-
Copper µg/L	24	BDL	-	-	-	-
Iron µg/L	24	110	185	390	-	310
Lead µg/L	24	BDL	-	-	-	-
Magnesium mg/L	20	<0.5	-	4	-	<0.5
Manganese µg/L	23	2.5	9	27		16.8
Nickel µg/L	32	BDL	-	-	-	-
Zinc µg/L	24	0.5	1.0	140	-	5.0

BDL = All samples below detection limits

Table 7 Stow Creek SW13 Statistical Summary (December 2013 to April 2014)

Analyte	N	Min	Median	Max	20th Percentile	80th Percentile
pH	18	5.0	6.06	7.49	5.69	6.82
Electrical Conductivity µS/cm	18	11.3	20.1	38.1	-	29.9
Dissolved Oxygen %	10	8.2	91.9	106	69.7	100.7
Total Suspended Solids mg/L	18	5	25.5	160	-	40.8
Total Dissolved Solids mg/L	18	5	5	30	-	18.2
Total Solids mg/L	9	16	41	82	-	57
Sulfate mg/L	18	BDL	-	-	-	-
Bicarbonate mg/L	18	4	9	13	-	13
Alkalinity mg/L	18	4	9	13	-	13
Hardness mg/L	18	3	3	10	-	7
Sodium mg/L	18	0.5	1.2	2.6	-	1.72
Chloride mg/L	18	<1.0	1	4	-	2.0
Calcium mg/L	18	<0.5	0.5	1.2	-	1.2
Total cyanide µg/L	10	BDL	-	-	-	-
Dissolved Metals						
Aluminium µg/L	17	5	27	240	-	53.6
Cadmium µg/L	18	BDL	-	-	-	-
Cobalt µg/L	18	BDL	-	-	-	-
Copper µg/L	18	BDL	-	-	-	-
Iron µg/L	18	69	130	700	-	380
Lead µg/L	18	BDL	-	-	-	-
Magnesium mg/L	17	0.5	0.6	1.7	-	1.14
Manganese µg/L	18	6	14.5	110	-	22.2
Nickel µg/L	18	BDL	-	-	-	-
Zinc µg/L	18	1.0	1.0	10	-	3.2

BDL = Below detection limits

The water quality for the Edith River upstream monitoring location (SW2) and the Stow Creek monitoring location (SW13) are highly variable. The water quality variability can be related to two aspects of the locations:

1. Rain events increasing runoff and associated increases in EC, turbidity, suspended solids and metals occur as shown in Table 6 and Table 7 maximum values.
2. Lack of rain also increasing EC and decreasing water quality as water flow decreases and evaporation increases resulting in poor water quality (SW13).

The ANZECC (2000) default guidelines are exceeded by the 80th percentile results for iron at site SW2 and SW13, most likely due to the mineralised geology of the area and impacts of rainfall run-off. Therefore, it may not be appropriate to apply the default guidelines for these analytes to SW4.

3.7 Selection of 2014/2015 Site Specific Trigger Values

The values shown in Table 6 and Table 7 were used to derive SSTVs for the parameters listed in WDL 178-3 as described in Section 3.5.1. The selected SSTVs for the 2014/2015 wet season are shown in Table 8 with an explanation of the selection process detailed in Table 8.

All analytes without SSTVs (and not shown in Table 9) are those analytes without references in ANZECC (2000). SSTVs have not been determined for those analytes, as the likelihood of chronic toxicity at the concentrations detected at SW4 is low.

Recent literature has also been used to determine appropriate SSTVs for magnesium, bicarbonate, chloride and sulphate. The TV for cobalt was selected from the Canadian guideline, as the 95% species protection TV recommended by ANZECC (2000) was of low reliability and the moderate reliability TV of 90 µg/L was considered to provide insufficient protection.

Table 8 Calculation of the 2014/2015 Wet Season SSTVs

Analyte	80th Percentile SW2	80th Percentile SW13	Combined 80th Percentile	ANZECC 80 % TVs	SSTV 2014/2015
pH	6.60	6.82	6.66	6.0-8.0	5.6 -8.0
Electrical Conductivity µS/cm	25.3	29.9	26.5	20-250	250
Dissolved Oxygen %	89.7	100.7	92.5	85-120	69 -120
Sulfate mg/L	<1	-	<1	-	129#
Bicarbonate mg/L	12	13	12.3	-	319##
Chloride mg/L	2	2.0	2.0	-	64^^
Total cyanide µg/L	BDL	BDL	BDL	7.0	7.0
Dissolved Metals					
Aluminium µg/L	30	53.6	35.9	150	150
Cadmium µg/L	BDL	BDL	BDL	0.8	0.8
Cobalt µg/L	BDL	BDL	BDL	90*	2.5**
Copper µg/L	BDL	BDL	BDL	2.5	2.5
Iron µg/L	310	380	328	300	328
Lead µg/L	BDL	BDL	BDL	9.4	9.4
Magnesium mg/L	<0.5	1.14	0.66	-	2.5^
Manganese µg/L	16.8	22.2	18.5	3600	3600
Nickel µg/L	BDL	BDL	BDL	17	17
Zinc µg/L	5.0	3.2	4.55	31	31

BDL Below detection limits

* *The moderate reliability trigger value for 95% species protection of 90 µg/L has been selected to provide a conservative SSTV for 80% species protection(ANZECC 2000. Chapter 8.3.7).*

** *Canadian chronic exposure value*

Elphick et al. 2011 Environ Toxicol Chem 30 (1):247-253

80% species protection TV. NSW OEH (2012)

^ *Van Dam et al. 2010 Environ Toxicol Chem 29(2):410-421*

^^ *95% species protection TV. Elphick et al. 2011a Environ Toxicol Chem 30 (1):239-246*

Table 9 Justification for the Selection of the 2014/2015 SSTVs

Parameter	Justification
pH	The 20th percentile of the background dataset of pH 5.6 is lower than the default trigger value for tropical lowland rivers in NT of pH 6.0. Therefore, the 20th percentile of the upstream reference sites was selected as the lower value for the pH range for the Mt Todd mine. The 80th percentile was lower than the default trigger value of 8.0, therefore the upper default trigger value has been selected as the SSTV.
Dissolved oxygen	The 20th percentile of the background dataset of DO 69.8 percent is lower than the default trigger value for tropical lowland rivers in NT of 85 percent. Therefore, the 20th percentile of the upstream reference sites was selected as the lower value for the DO range for the Mt Todd mine. The 80th percentile was lower than the default trigger value of 120 percent, therefore the upper default trigger value has been selected as the DO SSTV.
EC	The 80th percentile of the background dataset of 26.5 µS/cm is lower than the default trigger value for tropical lowland rivers in NT, 250 µS/cm. The ANZECC (2000) trigger was therefore selected as the SSTV.
WAD Cyanide	All the data for this analyte was below detection limits. Therefore, the ANZECC (2000) trigger of 7.0 µg/L was selected as the SSTV.
Dissolved Metals	
Aluminium	The 80th percentile of the background dataset of 35.9 µg/L is lower than the ANZECC (2000) 80 percent species protection level of 150 µg/L. Therefore, the ANZECC (2000) trigger was selected as the SSTV.
Cadmium	All the data for this analyte was below detection limits. Therefore, the ANZECC (2000) trigger of 0.8 µg/L was selected as the SSTV.
Cobalt	All the data for this analyte was below detection limits. However, the ANZECC (2000) of 1.4 µg/L was low reliability and NT EPA considered the moderate reliability ANZECC (2000) TV of 90 µg/L to provide insufficient protection. Therefore, the Canadian guideline for chronic exposure of 2.5 µg/L was selected.
Copper	All the data for this analyte was below detection limits. Therefore, the ANZECC (2000) trigger of 2.5 µg/L was selected as the SSTV.
Iron	The 80th percentile of the background dataset of 328 µg/L is higher than ANZECC (2000) low reliability trigger value of 300 µg/L. The 80th percentile was therefore selected as the SSTV.
Lead	All the data for this analyte was below detection limits. Therefore, the ANZECC (2000) 80 percent species protection level of 9.4 µg/L was selected as the SSTV.
Manganese	The 80th percentile of the background dataset of 18.5 µg/L is less than the ANZECC (2000) toxicants 80 percent species protection level of 3600 µg/L. The ANZECC (2000) trigger was therefore selected as the SSTV.

Parameter	Justification
Nickel	All the data for this analyte was below detection limits. Therefore, the ANZECC (2000) trigger of 17 µg/L was selected as the SSTV.
Zinc	The 80th percentile of the background dataset of 4.6 µg/L is lower than the ANZECC (2000) toxicants 80 percent species protection level of 31 µg/L. Therefore, the ANZECC (2000) 80 percent species protection level was selected as the SSTV.

3.7.1 Sulphate Trigger Value

Australia does not have a guideline for sulphate. As this is a commonly occurring anion, a guideline has been developed for application using a species sensitivity and safety factor approach (Elphick *et al.* 2011).

The guideline for soft water was calculated to be 129 mg/L with the species sensitivity distribution method, using data from species found in Australia including *Ceriodaphnia dubia* and *Pseudokirchneriella subcapitata* (formerly known as *Selenastrum capricornutum*). This is the same methodology that ANZECC (2000) used to derive the Australian trigger values. The soft water value has been selected for use as the 2014/2015 SSTV for Edith River.

3.8 Surface Water Monitoring

Vista Gold's Surface Water Monitoring Procedure (2013) (Appendix C) provides details on sample locations and a full suite of analytes required to meet WDL requirements. The Discharge Plan provides a sampling procedure to meet water quality requirements for daily sampling during discharge and monthly sampling at times of no discharge for the suite of analytes shown in Table 10.

Table 10 Analytes for SW2, SW4 and SW10 Daily Sampling during Discharge

	Analytes
In-situ	DO, temp, EC, pH
Metals (total and dissolved i.e. 0.45 µm)	Al, Cd, Co, Cu, Cr, Fe, Pb, Mg, Mn, Hg, Ni, Zn and speciated chromium (if 0.45 µm total Chromium returns a result greater than the Practical Quantification Limit [PQL])
Others	NO_3, PO_4, SO_4, bicarbonate, alkalinity, hardness, TDS, TSS, TS, Na, Cl, Ca, WAD cyanide, TOC, DOC

3.9 Monitoring Sites

Monitoring sites are as listed in WDL 178-3 Appendix 1. Vista Gold proposes to meet the 80% species protection dilution factor at SW4 to meet the requirements of the WDL. In addition to daily monitoring during discharge at SW2, SW4 and SW10, daily monitoring of the discharging RP will be undertaken. Surface water monitoring locations are shown in Table 11.

Table 11 Surface Water Monitoring Sites

Site Name	Site Description	Easting (UTM)	Northing	Latitude (degree, decimal)
SW2	Edith River at bridge on Edith Falls Road	189088	8431347	-14.1718
SW4	Edith River downstream of RP1 siphon (Burrell Creek) and RP1 spillway (West Creek), near boundary of mine property	186745	8431490	-14.1703
SW10	Edith River at old Stuart Highway causeway (8.7 km downstream from SW4)	179781	8430015	-14.183
RP1	Waste rock wastewater source	0187843	8432432	-14.1620
RP3	Batman Pit	0187055	8434993	-14.1388
RP7	Tailings storage area	0189211	8436326	-14.1270

3.10 SSTV Exceedance

For parameters that exceed the final site specific trigger values at the downstream monitoring location (SW4), the actions described in the decision trees in ANZECC (2000) and in Figure 3 below are implemented for physico-chemical stressors and for toxicants.

For physico-chemical stressors, the options are triggered where the median of the test site data exceeds the SSTV. For toxicants, the options are triggered where the 80th percentile of the test site data exceeds the SSTV.

The options are:

- Investigate the cause and duration of the exceedance;
- Implementation of remedial actions to improve discharge water quality; and/or
- Further site-specific investigations to determine the biological effects of the elevated parameters.

Further site specific investigations may include direct toxicity assessment (DTA) following ANZECC (2000) guidelines to determine biological effects in the downstream ecosystem. A single species representative of the receiving ecosystem may also be used in an ecotoxicological assessment to provide a more timely result. The aim of this investigation would be to identify the source of the contaminants, and to determine if the elevated concentrations are adversely impacting on the waters downstream of the discharge point.

3.10.1 Daily Monitoring at SW4

As discussed previously, sub-samples of SW4 will be analysed by North Australian Laboratories in Pine Creek for selected chemicals; notably sulfate, aluminium, copper, nickel and zinc. The results from the sub-samples will be received by Vista Gold on the same day of sampling, thus allowing a rapid response to, and implementation of, management actions that may be triggered by the water quality results. Management actions may include the following:

- Changing the dilution factor to represent current water quality.
- Lowering the dilution factor if SSTVs are exceeded at SW4.
- Ceasing discharge if SSTV is 2x SSTV (as per Figure 3). These results will be confirmed upon receipt of NATA results. Urgent analysis of the results can be requested by Vista Gold to improve turn-around time by the NATA laboratory.
- Improve reporting time of exceedances to the EPA and/or DME.

3.11 Selection of SW4 as Monitoring Point

As the mixing zone validation study has not yet be conducted (Section 5), the current WDL 178-3 monitoring location at SW4 has been selected to meet the 80 percent SSTVs calculated for the Edith River. From the preliminary desktop study, site SW4 is within the mixing zone and will not meet ANZECC (2000) 95 percent trigger values. Dilution factors calculated for RP3 discharge will enable the 80 percent SSTVs to be met at SW4 and the 95 percent trigger values to be met at SW10 (with the exception of copper).

It would be preferable to have a monitoring location downstream of this site however the topography of the area is such that significant financial expenditure would be required to ensure safe reliable access for personnel to the site.

3.12 Application of 80 Percent Species Protection Dilution Factor

The dilution algorithm derived in this Discharge Plan (Section 4) has been developed to protect 80 percent of resident species from a 10 percent decrease in growth or reproduction in the Edith River ecosystem for wet season 2014/2015 during site dewatering.

Vista Gold proposes to meet the 80 percent species protection dilution factor at site SW4 as required by the WDL 178-3 for discharge of treated RP3 water, RP1 or RP7 untreated mine waters. Water quality data for SW4 will be compared against the SSTVs in Table 8.

An exceedence which triggers the investigation process as detailed Figure 3 is defined as:

- A SSTV (as listed in Table 8) concentration exceeding the rolling seven day 80th percentile for that SSTV(NOTE: the 80th percentile was selected as it is not possible to calculate a 90th or 95th percentile from a data set of seven points).
- During the first week of discharge, prior to obtaining seven data points for each Monitoring Value, each daily data point exceedence is investigated as per Figure 1; or
- Exceedence of an 80th percentile of the SSTV during a single discharge event (less than 7 days).

The selection of the 80th percentile of a rolling data set for a maximum 7 days fulfils two main requirements for environmental protection.

1. The use of the 80th percentile will detect a single high reading of a SSTV (Table 8), however a single high reading is usually related to a laboratory or sampling error. A single high reading of a SSTV as a pulse (short-term) exposure is unlikely to adversely impact downstream aquatic populations and the long term (chronic) exposure to elevated concentrations is of greater concern.

2. The seven day rolling 80th percentile also relates to the duration of exposure of the most sensitive species tested in the ecotoxicology studies.

If any of the SSTVs are exceeded as listed above, an investigation process as detailed in Figure 3 will be implemented upon receipt of analytical data from the laboratory. This investigation procedure follows ANZECC & ARMCANZ (2000).

3.13 Time Frame for Exceedence Investigation

Should a SSTV (shown in Table 8) be exceeded at SW4 during any discharge from the mine as defined in Section 3.13, and investigations reveal that follow up sampling of the mine discharge and ambient water are required, the follow up sampling will occur as soon as practicably possible. By using the North Australian Laboratories at Pine Creek, results will be received the same day. This will allow Vista Gold to contact the NATA accredited laboratory and request a rapid turn-around of sample results and testing for metals on 0.1µm filtered samples and Chelex extraction to assess bioavailability. A duplicate sample of each SW4 sample collected by Vista Gold is retained by the laboratory for this purpose. In the meantime Vista Gold will implement the appropriate management actions for the exceedance, which may include additional sampling at key locations to assist with the isolation of any passive contaminant sources. This will provide an early warning to Vista Gold that there is potential to exceed the SSTVs as defined in Table 8. The NT EPA will be advised of an exceedence.

The risk assessment process will commence upon receipt of the laboratory results from the follow up sampling (the risk assessment may be conducted after the receipt of the duplicate sample bioavailability results if it has been determined that there is no sampling or laboratory error). Therefore, the time frame from the conclusion of the investigation process to the commencement of the risk assessment process is anticipated to be approximately 2 days. The risk assessment will take approximately one day. Another day is required to compile the report. A total of 4 to 5 working days is required to provide a completed report to NT EPA. If the exceedence has not resulted from a laboratory or sampling error, the report may be completed in a minimum of 4 days from initial exceedence, by using the local laboratory as a guide to exceedances.

3.14 Cease Discharge

Vista Gold will cease discharging from a water source (RP3, RP1 or RP7) if the SSTVs listed in Table 8 are exceeded by a factor of 2 or more. The discharge will cease upon receipt of laboratory results, i.e. the earliest known time of exceedence.

A factor of 2 was selected to be applied to the SSTVs for ceasing discharge, based on concentrations that may have the potential to cause chronic toxicity to sensitive aquatic species within the mixing zone. Acute toxicity is unlikely in the mixing zone with a 1-2 day exposure at these concentrations.

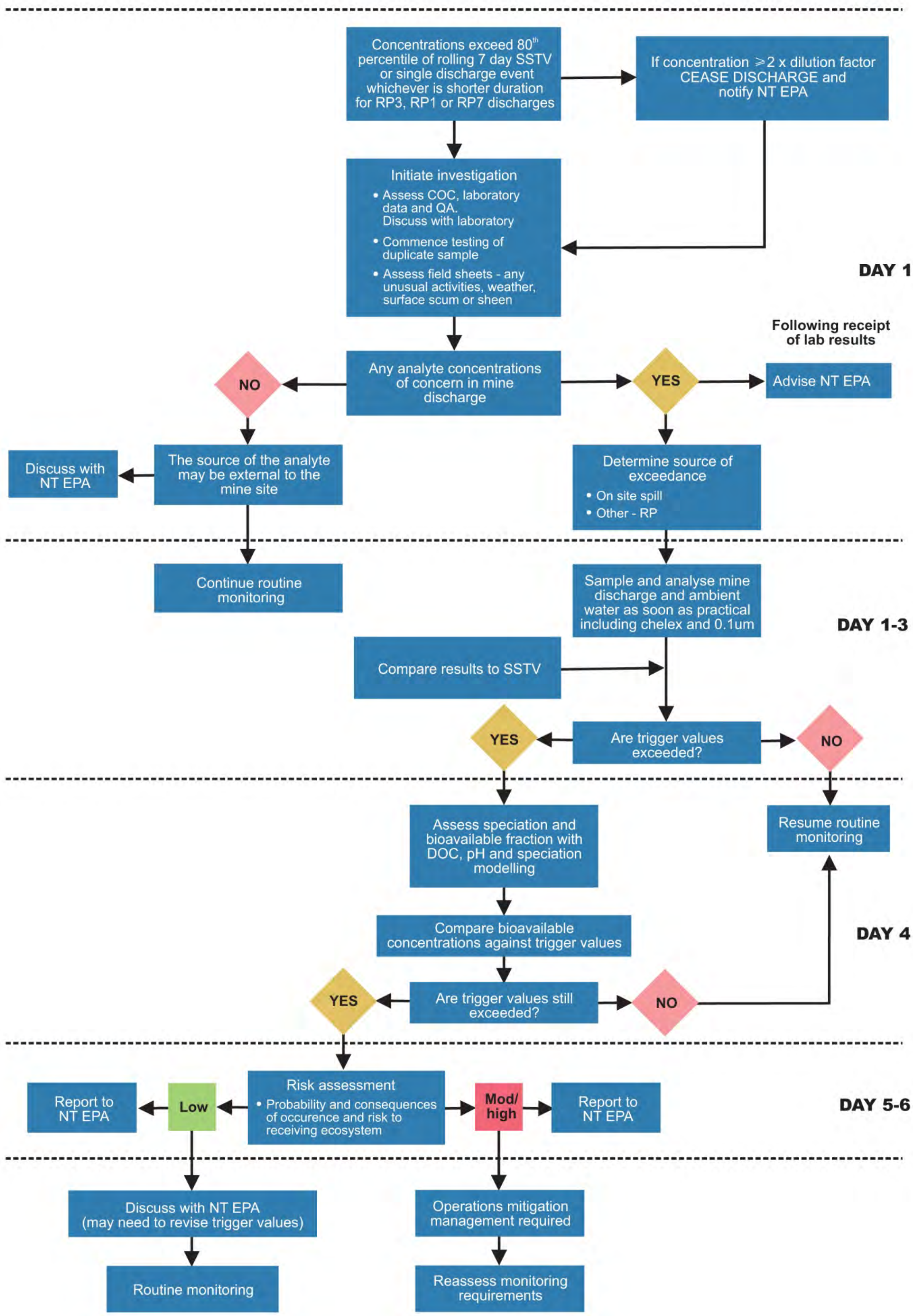

Figure 3 Investigation Process for Exceedance of SSTVs

4. Dilutions to meet SSTVs

4.1 Introduction

As discussed previously, due to the potential for rapidly changing water quality in RP3, the use of a direct toxicity assessment (DTA) result obtained from samples collected at the end of the dry season to calculate a 2014/2015 wet season dilution factor is problematic.

The application of additional water treatment in RP3 during late 2014, and rainfall during the wet season, should result in continually improving water quality in the pit. The use of a dry season DTA result for calculating the dilution factor for RP3 will be overly-conservative and may limit the amount of water able to be pumped out of the pit. Further, pumping untreated water from RP1 or RP7 will also change the water chemistry in RP3, possibly resulting in poorer water quality.

Therefore, the use of a single DTA at the end of the 2014 dry season will not provide an accurate indication of the dilution required to meet the SSTVs at SW4. Also, conducting DTAs each time the water chemistry changes will not provide useful results as:

1. The water chemistry in RP3 is changing on a daily basis (due to treatment, rainfall and possible inputs from RP1 and/or RP7).
2. DTA results from the laboratory may take up to 8 weeks and therefore not be applicable to the current water quality.

Toxicity units from historical ecotox testing by ERISS, NT EPA, Crocodile Gold and Vista Gold have been used to derive a dilution algorithm that can be used to calculate the dilution factor, based on the current chemistry of a discharge water. This method takes into account analysed chemicals that are considered to be contributing the majority of the measured toxicity (calculated from DTAs) within the discharge.

The following is a discussion of the development of a dilution algorithm that uses the data available at the time of testing. The dilution algorithm does not intend to determine 100% of the contributors to toxicity, as it is recognised that the physico-chemistry of the RP and receiving waters may have ameliorating factors. This has partially been taken into account by using the upstream water as dilution water in all DTAs.

This method does not attempt to identify all contributors to the measured toxicity, but has been developed to provide a practical method for operators to modify the dilution of mine water with rapidly changing chemistry, due to operational procedures (e.g. treatment and/or input of poor quality water) for maximum discharge to meet operational objectives listed below.

Water Treatment Objectives

The treatment and discharge of RP3 water will allow the DME to meet their objectives at the Mt Todd site. These objectives are:

- To reduce the on-site water inventory.
- To reduce the risk of an uncontrolled discharge from RP1, RP7 and RP3.

4.2 Method

Vista Gold will conduct daily testing on RP3 prior to discharge and during discharge, to monitor water quality within the pit in the vicinity and depth of the discharge pumps. Vista Gold intend to use a Pine Creek laboratory (North Australian Laboratories Pty Ltd) that can provide same-day results which will be used to calculate a dilution factor that will allow the maximum volume of water to be discharged to meet the 80 percent species protection SSTVs at SW4 and comply with the WDL.

The chemistry and the dilution factors determined for an 80 percent species protection factor using the BurrliOZ species sensitivity distribution (Campbell *et. al.* 2000) derived from DTA of gold mine discharges provided by ERISS, NT EPA, Vista Gold and Crocodile Gold Australia Operations (CGAO), have been used to determine the correlation of chemistry and toxicity. Ecotoxicity data was provided by CGAO for their Pine Creek and Cosmo Howley and Brocks Creek Project Areas, to provide additional data to calculate an algorithm that can then be applied with a greater level of confidence (GHD 2014a, GHD 2014b). CGAO data were considered appropriate for use, given that the mine sites are in close proximity and the species and endpoints used in bioassays are similar in all DTAs.

A total of 18 water samples were used to calculate the dilution algorithm, all of which were obtained between 2010-2014. This number of data points provides an algorithm with a high level of confidence. These samples provide a wide variety of water qualities from untreated samples with poor water quality to treated samples of better quality. This data has previously been supplied to the NT EPA in various reports. All the chemistry and DTA dilution factors are located in Appendix D

4.2.1 Trigger Values

Trigger values used to calculate the toxic units for the dilution algorithm are the 80 percent species protection SSTVs calculated to be applied to water quality at SW4. These SSTVs are listed in Section 3.

4.3 Toxic Units

To derive a formula for determining dilution factors for Mt Todd discharge, previous ecotoxicity dilution data (calculated following ANZECC (2000) guidelines for 80 percent species sensitivity distributions (SSD)) from ERISS, NT EPA, Vista Gold and CGAO were correlated with sulfate, aluminium, copper, nickel and zinc chemical concentrations, and the toxicity units for each chemical was determined. The toxicity units were calculated using ANZECC (2000) 80 percent species protection and site specific trigger values as shown below:

TU = concentration / 80 percent species protection site specific trigger value

The toxicity units for each chemical were added to obtain the total toxicity units for that sample. A linear correlation was then conducted to assess the relationship between total toxicity units and dilution. The formula for the correlation can then be used to calculate the appropriate dilution based on toxic units derived from the chemistry of the sample. This method takes into account the contribution of each selected chemical to toxicity.

4.4 Selection of Chemicals

From the ecotox data to date and the toxicity units shown in Appendix D at low metal concentrations sulphate and other ions contribute the majority of the toxicity. Once zinc and copper concentrations increase, these contribute the most to toxicity, with copper contributing >60 percent of the toxicity at high concentrations.

The metals contributing to the majority of toxicity in the sample were selected for inclusion in the calculation of the algorithm. Aluminium was selected as untreated water contains high concentrations of aluminium. The SSTV was selected as the TV for aluminium as the pH at SW4 is above pH 6. As discussed previously, sulfate contributes to toxicity at low metal concentrations, therefore, sulfate was selected for inclusion in the algorithm calculation. Copper, nickel and zinc contribute the majority of the toxicity in poor water quality, therefore these metals were selected to be used to calculate the algorithm.

4.5 Results

The Vista Gold ecotoxicity data was added to the CGAO data, with data from the NT EPA report (NT DLPE 2012). Total TUs were calculated for sulfate, aluminium, copper, nickel and zinc based on the data supplied in Appendix F. The data used in the algorithm is shown in Table 12. Figure 4 shows the linear regression for the Toxicity Units against dilution for using data from Table 12.

Table 12 Toxicity Units (SO_4, Al, Cu, Ni and Zn) and Dilution Data

Date	Site	TUs	Dilution
Jan-12	RP1	2060	1219
Oct-11	RP3	143	58
Apr-12	RP1	2415	1000
Oct-12	RP7	8941	4545
Jan-13	RP3	2676	1123
Mar-13	RP3	14	20
Dec-13	RP3	186	132
Jan-14	RP1	4822	1666
Apr-13	CHCK03	69	29.4
Apr-13	CHCK05	601	435
Apr-13	BCSW16	20	15.3
Apr-13	BCSW12	4	2.5
Apr-13	PCPWD	277	238
Apr-13	PCCK04	21	25
Mar-10	PCPWD	2277	1000
Mar-10	TGEP	1512	900
Mar-10	CHCK05	49	30
Jun-14	CGAO Treated	61	31

A linear regression was conducted on the data in Table 12 and shown in Figure 4. The R^2 value is 0.9683, which shows high correlation between toxicity and toxic units. Additional data points can be added to the data set following future DTAs.

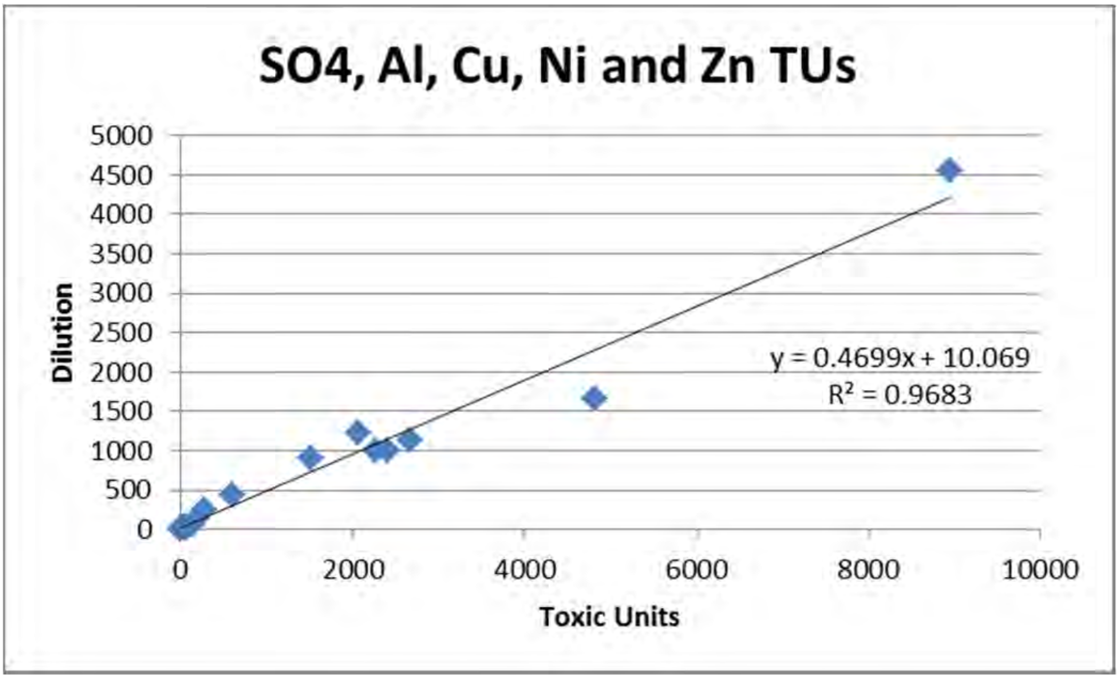

Figure 4 Linear Regression for Dilution Algorithm

4.6 Application Method

The algorithm shown in Figure 4 has been derived to apply to pumping rates based on the flow in the Edith River and the water chemistry in each pit, so that the SSTVs are met at SW4.

This algorithm can be applied to future chemistry analysis of sulfate, aluminium, copper, nickel and zinc to derive the dilution required to meet WDL requirements for environmental protection of the Edith River:

- Total Toxicity Units (SO_4, Al, Cu, Ni and Zn): $y = 0.4699x + 10.069$

This algorithm will provide a conservative estimation of dilution at low TUs which are expected to be found in RP3 after the 2014 treatment process.

4.7 Validation of Method

A DTA will be conducted on the RP3 sample after 1GL has been released from RP3 during the 2014/2015 wet season to validate the algorithm and provide support for the dilution factor for RP3 discharge for the water chemistry tested to meet the 80% species protection level at SW4.

Daily sampling will be conducted at SW4 to meet WDL requirements to ensure SSTVs are met. Sampling will be conducted at SW10 (as per the WDL) to assess if the 95% species protection level is met at SW10 (with the possible exception of copper).

Commitment 1

A full DTA will be conducted on the RP3 sample after 1GL has been released from RP3 during the 2014/2015 wet season to validate the algorithm and provide support for the dilution factor for RP3 discharge for the water chemistry tested to meet the 80% species protection level at SW4.

4.8 Peer Review of Method

A copy of this methodology has been provided to Dr Ross Jeffree for an independent peer review. Dr Jeffree's comments are located in Appendix E.

4.9 Future Toxicity Assessment

Vista Gold propose to conduct screening bioassays using the cladoceran reproduction test on a sample from SW10 (or other site downstream of the discharge point) and SW4 during discharge. This sample will be compared with the upstream SW2 sample to determine if any significant toxicity is exhibited at the site which can be attributed to the discharge. These bioassays will also assist in the validation of the mixing zone. A full suite of chemistry will also be conducted on the samples.

4.10 Discussion

The method used for the development of the algorithm has been derived from Schmidt *et al.* (2010) and is a conservative version of the cumulative criterion unit (CCU) model. The CCU is a toxic unit approach that predicts additive toxicity of trace metal mixtures to aquatic organisms in freshwater streams. The CCU model takes into account ameliorating factors such as hardness, pH, dissolved organic carbon, Ca^{2+} and Mg^{2+} concentrations.

The method used in this assessment has not taken the effect of ameliorating factors into account. The method used here assumes that the dilution rate calculated from the species sensitivity distribution (SSD) has already accounted for any ameliorating factors. This method is also based on the assumption that bioavailable metals are the primary cause of toxicity in these samples, and that ions contribute to toxicity at low metal concentrations. This assumption is validated by the significantly high R^2 value.

This method provides the simplest way of calculating the dilution factor based on ecotoxicology and capturing chemistry data and the contribution of each selected chemical to toxicity.

5. Flow Control Mechanisms for Discharge to Meet the Dilution Factors

This section describes the mechanisms, including infrastructure and telemetry, installed at Mt Todd that will control discharges to meet the dilution factors at SW4.

5.1 RP3 Discharge

The discharge of treated RP3 water will occur via the following mechanism:

- Release of treated RP3 water via variable speed pumping system up to 1000 L/s capacity.
- Pump flow rate controlled by automated pumping system.
- Pumping rates determined from volume of water available in Edith River for discharge and applicable dilution rates.
- Flow and water quality in Edith River measured by gauging station at monitoring location SW4.
- Real time flow at SW4 reported via radio telemetry to pump controller.
- User adjustable dilution rates are set in pump control system.
- Pump control system uses river flow rates and dilution ratio to regulate the pump flow rate.
- Height, flow and water quality measured at SW3 gauging station downstream of Batman confluence with Stow creek.
- Pump flow rate from RP3, Edith River flow rates and quality from SW3 and SW4 reported live to site office via radio telemetry connection.
- Live telemetry data available to Vista Gold Darwin office via internet link.

5.2 RP1 Discharge

The discharge of untreated RP1 water will occur via the following mechanism:

- Release of water via existing siphon system.
- Flow rate manually controlled by valves.
- Flow rate reported by inline flow meter.
- Discharge enters Burrell Creek.
- River height, flow and water quality continuously monitored by gauging station SW4 downstream of Burrell creek confluence with Edith River.
- Siphon flow rate reported live in site office by radio telemetry.
- Height, flow and water quality at SW4 reported live at site office via radio telemetry.
- Live telemetry data available to Vista Gold Darwin office via internet link.

5.3 RP7 Discharge

The discharge of untreated RP7 water will occur via the following mechanism:

- An appropriate mechanism for measuring RP7 discharge flow rate shall be implemented prior to discharging from RP7.
- Release of water from Decant Pond valve in decant ponds.
- Flow rate manually controlled via butterfly valve.
- Discharge enters Horseshoe Creek.
- Creek height and flow measured by continuous monitoring gauging station downstream of decant ponds on Horseshoe Creek.
- Temperature, Conductivity and pH water quality parameters also measured at Horseshoe Creek gauging station.
- Horseshoe Creek gauging station data reported live to site office via radio telemetry.
- Height, flow and water quality at SW4 reported live at site office via radio telemetry.
- Live telemetry data available in Vista Gold Darwin office via internet link.

6. Mixing Zone Study

Appendix F summarises the results obtained for the mixing zone study conducted in 2013 following the methodology outlined in GHD (2012a).

Results of the mixing zone study conducted in 2013 were based on the following:

- A discharge rate of 15 percent contribution from the Mt Todd mine site.
- The 2013 ISSTVs calculated for treated RP3 discharge.
- The flow rate at SW4 is assumed to be 85 percent of that measured at station G8140152, 3.7 kilometres downstream from the mine site.

The results of the 2013 study indicate that the size of the mixing zone stabilises at higher flow rates, reaching a plateau around the median flow rate (Appendix F).

The rate of transverse mixing in any river is controlled by several site specific factors. The precise transverse mixing characteristics of this reach of the Edith River are unknown. In the absence of site specific mixing data, a realistic range of transverse mixing rate parameters were modelled. The size of the mixing zone results varied from a minimum of around 1000 m to around 3500 m, depending on the parameters used and the flow rate at SW4. Therefore, the mixing zone modelling shows that the mixing zone does not extend to sample site SW10 which is 8.7 kilometres from SW4, and site SW4 is within the mixing zone.

Given the curved river path and the variability in channel cross section (both factors that promote transverse mixing) it is possible that mixing could occur more rapidly than predicted in these results. In situ mixing measurements would be required to further refine these mixing zone estimates. This analysis has assumed that the flow is discharged on one bank of the river, which is effectively the worst case scenario for transverse mixing.

6.1.1 Mixing Zone Validation

WDL 178-3 item 33.1.1 requires:

“The Licence Report must include:

33.1 Outcomes associate with the ongoing studies including:

33.1.1 Results of the mixing zone modelling, mixing zone validation and mixing zone confirmation; …”

Due to the short discharge of treated RP3 water (six days, 1 - 6 February 2014), insufficient time was available to notify the Ecotoxicology laboratory that testing was required. Ecotox Services Australasia require two weeks notification that samples will be arriving, and so Vista Gold were unable to provide samples to the ecotox laboratory from downstream locations for validation of the mixing zone during the 2013/14 wet season using screening bioassays.

It is important to note that due to access and safety issues, the gauging station at G8140152 is unable to be utilised as a routine surface water monitoring station, and may not be safely accessible to provide water quality results for inclusion into the validation study.

Commitment 2

Vista Gold will develop and conduct a mixing zone validation and confirmation study during the 2014/15 wet season, providing there is adequate flow and the mine is releasing water to the Edith River.

7. Sediment Monitoring Summary

7.1 Introduction

The information provided in this section is a summary of "Mt Todd Macroinvertebrate & Sediment Monitoring Report 2013-2014 Wet Season" prepared by Envirotech Monitoring. This report is reproduced in full in Appendix G.

Sediment analysis to date suggests that metals are not being held locally in the sediments of the Edith River, and that the majority are being carried in suspension further downstream. Assessment also indicates that there is little difference between sediment samples collected near the edge of the river as opposed to those from the bottom of deep pools. These findings point to the velocities of the river in the sampled reach of the catchment being too high to permit accumulation of the finer colloidal particles holding heavy metals. However, both of these sample types have been collected from the river bed which is largely composed of sand and coarser grained material. The walls and broader river banks are composed of a very different sediment/soil structure and consequently, in 2013 and 2014, sediment samples were collected from these areas where finer particulates and organics are trapped and held in place by the riparian root structures.

7.2 Methodology

The similarity in chemistry of benthic pool and benthic edge sediments in 2012 suggested the benthic substrate of the rivers under examination is fairly homogenous with respect to the retention of metals and other pollutants. As in 2013, sediment samples were also taken from the walls of the river bank at the river's edge (edge sediment samples), where free or bound metals been shown so far to have the greatest potential for settlement.

The increased chemical concentrations found in edge sediment samples, particularly at sites downstream from the mine, are expected to be the result of accumulation over time and not related to a specific year of discharge. Therefore in 2014, the number of sites where sediments were collected was reduced to five to provide an initial comparative dataset with prior results. Further detailed sampling was planned following the identification of unexpected results. Three sites were sampled on the Edith River. On the Fergusson River, two of the three macroinvertebrate sampling sites were sampled for reference data.

For the above five sites, sediments were collected at one of the three replicate locations; the same location at which water quality was sampled. For each sediment sample type, three samples were collected using procedures consistent with previous years.

All sediment samples were stored at 4 ºC prior to dispatch to a NATA accredited laboratory for analysis. These samples were analysed for:

- pH (in 1:5 soil to water ratio) and total organic carbon (combustion)
- Metals and other analytes (mg/kg): Al, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn, U SO_4, Cl, NO_2, NO_3, NH_4 CN, Ca, P, Mg, Na, As, Be, Cr, La, Mn, Pb

The selection of elements for analysis was based on those that have appeared in detectable concentrations within the discharge effluent.

7.3 Results and Discussion

There continues to be detectable and elevated levels of select metals and ions at downstream sites. Last year's analyses along the downstream spatial gradient showed a number of metals and ions at elevated levels originated from the mine, as they matched the chemistry of the discharge waters. Discharge is known to have been occurring since mine closure, with historical volumes of discharge being significantly larger than those of more recent times. Thus it is likely that more recent concentrations are a reflection of an accumulation over time, rather than being related to a specific year of discharge.

This year only four parameters (Fe, Al, K and SO_4) showed further increases in concentration at downstream Edith River sites compared with last year. However, the increases in Fe and Al were not attributable to this year's discharge activities, as water chemistry data from RP3 discharge waters shows the concentration of these two metals were extremely low. The observed increases are more likely to have originated from passive sources, such as Horseshoe Creek, whose catchment contains the tailings dam. Past surface and groundwater samples from this catchment indicate seepage from the Tailings Facility.

Elevated levels of Al have also been measured in Philips Creek, which confluences with the Edith River between the upstream and downstream sites. The influence of passive sources is likely to be particularly significant this year, as sampling was conducted later in the season than usual.

SO_4 and K were present in 2014 RP3 discharge waters, however, it is again likely the elevated SO_4 can be attributed to passive discharge from Horseshoe Creek rather than from the very small window of discharge from RP3. Potassium levels were also generally higher across all sites this year with groundwater the likely contributor.

The higher edge than benthic concentrations for many chemical parameters across all sites were again observed this year. These edge zones are known to correlate with the finer particulate matter held in place by riparian vegetation, that act as absorption points for contaminants. The drivers for the increased edge concentrations are likely to be many, and may include factors such as physio-chemical adsorption from the water column, biological uptake (particularly by bacteria and algae), sedimentation and physical entrapment of enriched particulate matter.

In summary, an increase in only two of the 27 chemical parameters does not provide sufficient evidence of a further exacerbation of the downstream sediment concentrations from discharge activities. This is consistent with what was expected given there were less than 10 days of discharge of treated RP3 water during the wet season. This discharge also occurred a few months prior to sampling, with follow up freshwater flows likely to have had a flushing effect. In addition compared with historical discharges, the quantity of treated water was significantly lower and the water quality significantly higher.

8. Macroinvertebrate Data

8.1 Introduction

The information provided in this section is a summary of "Mt Todd Macroinvertebrate & Sediment Monitoring Report 2013-2014 Wet Season" prepared by Envirotech Monitoring. This report is reproduced in full in Appendix G.

Treated mine water enters the Edith River from RP3 via Batman Creek and Stow Creek under controlled discharge. Historically, the majority of mine water that entered the Edith River under controlled discharge previously occurred at the RP1 discharge point into Burrell Creek prior to entering the Edith River. Other potential sources of mine water include discharge from Batman Creek and Horseshoe Creek, which pass water to Stow Creek prior to the Edith River, and discharge from West Creek. Stow Creek receives seepage and pond overflow from RP7, RP2, RP5 and the Heap Leach. West Creek receives potential overflow from RP1. Anthropogenic discharge can occur from RP7, RP1 and since 2013, from RP3.

At the Mt Todd mine site, pelagic macroinvertebrates have been monitored since 2003. From 2003 to 2010 five sites were monitored annually by the then Northern Territory Department of Resources (DoR), with a single macroinvertebrate sample collected at each site. The number of sites included in the macroinvertebrate monitoring program has been increased to eight sites with three replicates collected.

8.2 Method

Pelagic macroinvertebrate samples were collected and processed following standard Northern Territory AusRivAS field and laboratory protocols. At each site replicate, macroinvertebrates were collected from riverine edge habitat, one of the two most common habitats present in Northern Territory waterways (the other being sand bed). At each location consistent, suitable edge habitat was identified. These were areas where the edge was as vertical as possible, abundant root material was present and water velocity minimal (often also associated with a pool). Those edge areas characterised by Pandanas palm roots and/or undercut banks were avoided where possible.

Benthic macroinvertebrates were sampled using standard procedures for assessments of benthic fauna in freshwater environments. Benthic samples were collected from deeper areas of the river where water velocity was considered slowest at each of the eight main site locations. These areas were characteristically deep, wide pools. These criteria were selected as they represent the riverine habitat where any pollutants bound to the fine organic material suspended in the water have the greatest chance of settling out on to the river bottom.

Using recommended keys, insects and crustaceans were identified to family level, with some to genus; and other non-insects to order or class. Information from other contaminant studies suggests that macroinvertebrate identification at such coarse taxonomic levels results in minimal loss of information. For each sample, the abundance of each taxon identified was recorded in a tally sheet.

8.3 Results and Discussion

In 2014 there was no statistically significant difference in the community composition of pelagic macroinvertebrates between reference sites located on the Edith River upstream of the mine, and sites downstream of discharge points. The composition of communities on the Fergusson River did differ significantly from both upstream and downstream Edith River sites, supporting past conclusions that the two river systems are inherently different with respect to their macroinvertebrate compositions.

Further targeted analyses confirmed that within the Edith River ecosystem, there was no significant impact of discharge activities on the downstream macroinvertebrate communities, with upstream and downstream Edith River sites showing similar macroinvertebrate compositions. Furthermore, temporal analyses showed the compositions of upstream and downstream sites on the Edith River have shown a steady increase in similarity over the last three years.

Analyses of other macroinvertebrate community measures showed that although taxa richness was marginally greater at reference compared with downstream sites, this was mostly attributed to a higher taxa richness of Fergusson river sites, with Edith upstream and downstream sites showing similar taxonomic richness. Differences in taxa between reference and downstream sites were not a reflection of mine discharge effects but rather chance sampling of rarely encountered taxa. Total macroinvertebrate abundance and the percentage of abundance comprised of pollution sensitive taxa also differed significantly; but did not reflect an impact of mine discharge with both variables greater at downstream sites.

A temporal analysis of macroinvertebrate community composition from 2003 to 2014 showed a statistical difference between reference and downstream sites that was dependant on year. In contrast to 2014, there was a significant difference in composition between reference and impact sites in 2012 and 2013. However, the detection of a statistical difference in community composition in 2012 and 2013 is most likely due to the increase in sampling sites and number of samples collected; and not as indicated by the temporal analysis, a result of compositional changes since 2011. Nevertheless, the magnitude of difference between reference and downstream sites is small and within the range of natural annual variability witnessed across sites within a similar treatment.

9. Risk Assessment

9.1 Method

An Environmental Risk Assessment (ERA) was undertaken to assess the risks posed by discharges from the Vista Gold facility (the facility) to Edith River and to the beneficial use "*Protection of aquatic ecosystems*" as defined under the *Water Act* (1992). Specifically, the focus of this ERA is on the aquatic environment of the Edith River in the vicinity of surface water monitoring site SW4, which is downstream of the RP3 discharge point.

A semi-quantitative approach was used to conduct the risk assessment. This type of assessment provides a high level (broad) understanding of the possible risks to the receiving environment.

The overall approach that has been adopted for this assessment is consistent with AS/NZS ISO 31000:2009 (which supersedes AS/NZ 4360:2004). The method used for the risk assessment is based on the Aquatic Value Identification and Risk Assessment (AVIRA) process (Riverness 2014) and is compliant with the AS/NZS ISO 31000:2009 risk assessment framework.

This method provides a detailed approach to assess risk within a spatially based framework. The method identifies the association of threats to assets, values or beneficial uses; and recognises that not all threats have an equal impact on all values. The risk assessment matrices are located in Appendix H.

The risk assessment was conducted in three phases:

Phase 1 – Problem Formulation – establishing the context, review of beneficial uses, threats and risks and development of the risk analysis method.

Phase 2 – Risk analysis – conduct the risk analysis.

Phase 3 – Risk Characterisation.

This approach is highly effective for prioritising ecological risks and informing the development of risk management strategies.

9.2 Phase 1 – Establishing the Context

The problem formulation stage is the crucial first step in the process that defines the overall scope and boundaries of the risk assessment. The problem formulation stage for the risk assessment includes:

- Identifying the environmental management of discharges from the Mt Todd mine.
- Identification of the spatial boundaries.
- An overview of the existing background information on environmental values, threats and known impacts posed by the discharge of mine water.
- Development of a detailed risk register.

9.2.1 Spatial Boundaries of the Environmental Risk Assessment

The spatial boundary utilised for this ERA is the aquatic environment of Edith River in the vicinity of surface water monitoring site SW4 (the WDL 178-3 compliance point).

9.2.2 Water Quality Monitoring Data and Trigger Values

Surface water monitoring is undertaken across a range of sites upstream and downstream of the SW4 compliance point. For the purposes of this ERA, water quality monitoring data from the SW4 surface water monitoring site has been used to determine the risks posed to the aquatic values.

Vista Gold conducted water quality monitoring of the Edith River from November 2011 to April 2014. The 20th and 80th percentile for pH and 80th percentile for all other analytes in this data set (Table 13) were compared with the 2014 Site Specific Trigger Values (SSTV).

The summary water quality data from SW4 is within the SSTV limits for key analytes and as such the risk to the beneficial uses of the Edith River is low. However, Vista Gold conducted minimal discharging during the 2013/14 wet season and therefore, the summary data in Table 13 is not the best representation of water during a discharge event.

In order to gain a better understanding of water quality at SW4 during a discharge event and the risk it poses to the beneficial uses of Edith River, water quality from SW4 during a 6 day discharge period has also been analysed (Table 14). The 20th and 80th percentile for pH and 80th percentile for all other analytes in this data set (Table 14) were compared with the 2014 SSTVs. The 2014 Discharge report is located in Appendix I.

The summary water quality from SW4 during the discharge period of the 1 to 6 February 2014 is mostly within the SSTV limits. However, pH is outside the SSTV at 20th percentile measurement and copper at the 80th percentile measurement. Therefore, pH and copper may pose a risk to the beneficial uses of Edith River. This risk is assessed in Section 8.3.

Table 13 Key SW4 Analyte Data Summary (2011-2014) and SSTVs

Analyte	Units	SSTV	Min	Max	Median	80th Percentile	20th Percentile
pH		5.6 -8.0	5.4	6.7	6.0	6.5	5.7
Electrical Conductivity	µS/cm	250	13	122	28	47	16
Dissolved Oxygen	%	69 -120	51	96	80	89	69
Sulfate	mg/L	129#	1	33	2	7	1
Bicarbonate	mg/L	319	1	17	8	12	6
Chloride	mg/L	64	0.5	3	2	2	1
Total cyanide	µg/L	7.0	2	6	2	2	2
Dissolved Metals							
Aluminium	µg/L	150	10	160	11	23	10
Cadmium	µg/L	0.8	0.1	0.1	0.1	0.1	0.1
Cobalt	µg/L	2.5*	1	1	1	1	1
Copper	µg/L	2.5	1	11	1	1	1
Iron	µg/L	328	140	560	210	308	144
Lead	µg/L	9.4	1	1	1	1	1
Magnesium	mg/L	2.5^	0.5	4.4	0.9	1.5	0.5
Manganese	µg/L	3600	6	280	26	45	12
Nickel	µg/L	17	0.1	2	1	1	1
Zinc	µg/L	31	1	130	4	6	1.4

To calculate percentiles in instances in which measurements were below laboratory detection limits, these values were halved.

* *The Canadian chronic exposure level of 2.5 µg/L has been selected to provide a conservative SSTV for 80% species protection*

\# *Elphick et al 2011 Environ Toxicol Chem 30 (1):247-253*

^ *Van Dam et al 2010 Environ Toxicol Chem 29(2):410-421*

Table 14 Key SW4 Analyte Data Summary (1 to 6 February 2014) and SSTVs

Analyte	Units	SSTV	Min	Median	Max	80th Percentile	20th Percentile
pH		5.6 -8.0	5.3	5.8	6.1	5.9	5.5
Electrical Conductivity	µS/cm	250	34	49	753	101	39
Dissolved Oxygen	%	69 -120	67	90	95	92	89
Sulfate	mg/L	129#	0.5	8.5	26.0	11.0	6.0
Bicarbonate	mg/L	319	5.0	9.5	11.0	10.0	8.0
Chloride	mg/L	64	0.5	1.0	67.0	1.0	0.5
Total cyanide	µg/L	7.0	2	2	2	2	2
Dissolved Metals							
Aluminium	µg/L	150	55	101	290	120	75
Cadmium	µg/L	0.8	0.1	0.1	1.4	0.2	0.1
Cobalt	µg/L	2.5*	0.5	16.0	1.0	2.0	0.5
Copper	µg/L	2.5	1.0	3.0	50	4.0	2.0
Iron	µg/L	328	80	130	230	170	110
Lead	µg/L	9.4	0.5	0.5	0.5	0.5	0.5
Magnesium	mg/L	2.5^	0.9	1.7	5.2	1.9	1.5
Manganese	µg/L	3600	12	45	200	63	23
Nickel	µg/L	17	0.5	1.5	17.0	2.0	1.0
Zinc	µg/L	31	9	15	340	24	12

Parameters highlighted in dark gray exceed the Site Specific Trigger Values.

To calculate percentiles in instances in which measurements were below laboratory detection limits, these values were halved.

* *The Canadian chronic exposure level of 2.5 µg/L has been selected to provide a conservative SSTV for 80% species protection*

\# *Elphick et al 2011 Environ Toxicol Chem 30 (1):247-253*

^ *Van Dam et al 2010 Environ Toxicol Chem 29(2):410-421*

9.2.3 Beneficial Uses

The identified beneficial use for the Edith River, as defined under the Water Act (1992), is the "*protection of aquatic ecosystems*". Broadly this covers water quality and all biota, such as macroinvertebrates, vertebrates (fish, amphibians and reptiles), algae, aquatic flora and their habitats.

9.2.4 Threats

The risk assessment process identifies threats such as the water quality parameters that are likely to cause negative impacts to aquatic values.

Threats are based on the water quality parameters that were analysed for the SW4 water quality monitoring program undertaken by Vista Gold between November 2011 and April 2014. Threats were screened to identify water quality analytes that were considered low risk. The screening process calculated percentiles for all analytes. In accordance with ANZECC (2000) the 80th percentile was used as the data value to screen analytes against the SSTVs. Water quality analytes for which the 80th percentile is below the SSTV (or the 20th and 80th percentiles were within the SSTV range, in the case of pH), were considered to pose a low risk to aquatic values (Table 13). As all analytes were identified as a low risk for water quality measured between November 2011 and April 2014 at SW4 a full risk assessment process is not required.

Nonetheless, to further the understanding of potential impacts from the discharge, analytes that were identified as outside the SSTV during the 1 to 6 February 2014 discharge event will be taken through the full risk assessment process (Table 14).

The key threats identified through the screening process were:

- pH
- Copper

It should be noted that the screening process assumes that threats for which the 80th percentile is below the SSTV would pose a low risk. However, it is possible that some of these threats still occasionally exceed the SSTV, and may have the potential to have a low-level impact on risk values.

9.2.5 Risk Analysis Method

The risk analysis assesses the potential risk posed by the mine discharge to the aquatic values at site SW4 and its vicinity. This phase of the assessment involves the development of a risk assessment method and risk register based on the water quality monitoring data and waterway conditions.

The AVIRA method consists of three components including:

- Defining consequence descriptors for the values identified.
- Defining a threat score for individual water quality analytes.
- Determining the level of association of the threat/benefit to the beneficial use or value.

These steps are outlined in further detail in the following sections.

Step 1 – Defining Consequence Descriptors for the Value

Consequence of impact descriptors were defined on a scale of one to five where one represented little or no impact and five was a significant impact.

The descriptors were developed for the beneficial use, are based on aquatic populations (encompassing aquatic flora and fauna) and are provided in Table 15 below.

Consequence scores are based on our understanding of the ecological condition of the Edith River and the 6 day duration of the analysed discharge event.

Table 15 Descriptors of Impact of Consequence

Score	Magnitude of Impact	Aquatic Values
1	Insignificant	<5 percent decline in aquatic populations
2	Low	5 to 10 percent decline in aquatic populations
3	Moderate	>10 to 20 percent decline in aquatic populations
4	High	>20 to 50 percent decline in aquatic populations
5	Extreme	>50 percent decline in aquatic populations

Step 2 – Development of Threat Scores

Threat scores provide an indication of the potential for an analyte to impact a beneficial use or value, i.e. the higher the score the greater the likelihood of an impact. Table 16 shows how the threat score ranking was determined for metals. For pH, the ranking was based on the exceedance occurring either over or under the SSTV and used values that were realistic for these parameters scales, i.e. pH 5.0-9.0.

Table 16 Threat Score Ranking

Score	Threat Score Ranking
5	>5 x Site Specific Trigger Value
4	>2 x Site Specific Trigger Value – 5 x Site Specific Trigger Value
3	> Site Specific Trigger Value – 2 x Site Specific Trigger Value
2	>0.5 x Site Specific Trigger Value - Site Specific Trigger Value
1	≤0.5 x Site Specific Trigger Value

Threat scores for each of the key identified threats are provided in Table 17 with **red/bold** text indicating where the 80th percentile of the measured values of the threat was in exceedance of the relevant SSTV.

Table 17 Threat Scores

Score	pH	Copper µg/L
5	<5.0 or >9.5	>12.5
4	5.0 - <5.5 or >9.0-9.5	**>5-12.5**
3	**5.5 - <6.0** or >8.5-9.0	>2.5-5
2	6.0 - <6.5 or >8.0-8.5	>1.25-2.5
1	6.5-8.0	≤1.25

Step 3 – Determining the level of association of the threat to the beneficial use or value

The term "association" is used to define the strength of the linkage between the threat and the beneficial use or value. Association identifies the level of influence a threat may have on a value, and is rated low, medium or high.

For the purposes of this ERA, copper has been identified as a threat and has been allocated a **high** association. Copper has a high association due to the direct toxicity it presents to aquatic biota. pH has been given a **high** association, due to its direct relationship to metal mobilisation and toxicity (the lower the pH, the higher the metal toxicity).

9.3 Phase 2 – Risk Analysis

The risk analysis identified low risks to the protection of aquatic ecosystems.

The focus of the risk assessment was to assign impact scores for each of the identified beneficial uses to threat relationships (associations) identified during the earlier stages of the risk assessment.

Scores were based on the threat tables defining levels of impact and Vista Gold's water quality monitoring data collated and analysed for site SW4 during a discharge event from 1 to 6 February 2014.

A summary of the risks is provided in Table 18.

Table 18 SW4 Summary of Risks during a Discharge Event 1 to 6 February 2014

Beneficial Use	Spatial Extent	Threat	Cons Score	Comments	Association	Threat/ Enhancer	Risk Score
Protection of aquatic ecosystems	SW4	Copper	1	Trace metals such as copper are toxic at extremely low concentrations and may act together to suppress algal growth and affect fish and benthos (Hoehn and Sizemore, 1977). Metals can have direct toxic impacts on aquatic fauna and can bioaccumulate and impact higher faunal trophic levels. Heavy metals can increase the toxicity of mine drainage and act as metabolic poisons. However, duration of the discharge was for 6 days.	High	4	L
Protection of aquatic ecosystems	SW4	pH	1	Increased acidity (i.e. reduced pH) can impact directly upon algae and macroinvertebrates, resulting in the loss of algae and other primary producers and thereby reducing the food available to herbivorous macro-invertebrate species (Courtney and Clements, 2002). Low pH also influences macro-invertebrates through disruptions of ionic balance across the organism's membranes (Jarvis and Younger, 1997). There can be a subsequent flow-on effect with a reduction in macroinvertebrates (an important part of the food web) resulting in a reduction in food source for higher trophic level organisms such as predatory macroinvertebrates, fish and reptiles such as turtles and crocodiles. Organisms such as snails with calcium carbonate shells are likely to have their shell dissolved in acidic waters (Kelly, 1988). Increased acidity of mine waters also increases the bioavailability of metals (Cherry *et al.* 2001) resulting in greater toxicity. This may then lead to the accumulation of metals in organisms. However, duration of the discharge analysed was for only 6 days.	High	3	L

9.4 Phase 3 – Risk Characterisation

9.4.1 Basis for the Risk Characterisation

Risk characterisation considers the key risks that water quality poses to the aquatic ecosystem of Edith River in the context of the objectives of the project.

In carrying out the risk assessment, it is noted:

- The risks to beneficial uses and values were assessed for the area in the vicinity of water quality sampling site SW4 for water quality measured between November 2011 and April 2014. No key analytes were found to exceed the 80th percentile SSTV, indicating a low risk to the aquatic environment.
- The risks to beneficial use and values were assessed for the area in the vicinity of water quality sampling site SW4 during a discharge event from the 1st to the 6th of February 2014. Copper and pH were identified to potentially pose a low risk to the aquatic environment.
- The risk assessment does not identify actual impacts to aquatic species. Instead it identifies a level of risk posed by a particular threat on ecological values. Levels of risk are identified through an assessment of potential sensitivity of values to particular threats and the level of the threat in the receiving environment.
- The assessment of threat associated with the range of analytes sampled in Vista Gold's water quality monitoring program has been based on calculation of 80th percentiles of measured values for data at site SW4. This provided a realistic assessment of water quality data at the site and aligned with approaches defined by ANZECC (2000).

9.4.2 Risks to Aquatic Ecosystems

The risks to the beneficial use and values were assessed for the area of Edith River in the vicinity of surface water monitoring site SW4. The risk assessment identified that copper and pH potentially pose a low risk to the aquatic ecosystem of Edith River at the monitoring site SW4 during discharge events. However, a longer term data set (water quality measured between November 2011 and April 2014) indicates that risk levels are low to nil at SW4. Scores were assigned conservatively, taking into account the most sensitive biota such as microalgae and macroinvertebrates.

10. Conclusions

This Discharge Plan provides information for the management of the Mt Todd discharge to Edith Creek for the 2014/2015 wet season. This report provides 80 percent species protection trigger values to be met at SW4 to ensure that the dilution ratios calculated from ecotoxicology and chemistry results for gold mine discharges are providing the appropriate environmental protection. A risk assessment conducted for SW4 shows that the risk to the site from RP3 discharge during 2013/14 wet season was low.

The mixing zone study will be conducted during the 2014/2015 wet season during mine discharges if flow rates and dilutions will allow. The results can be used to validate the dilution factors calculated from the algorithms provided in this plan.

This Discharge Plan (Revision 2) has been developed to meet the requirements of the WDL 178-4.

The dilution factors will be applied to the water discharging from the Mt Todd mine site. These dilution factors will be met at the Edith River at monitoring location SW4.

SSTVs have been calculated to confirm that the dilution factors are being met at SW4. Several lines of investigation will be/have been used to assess and validate the dilution factors including:

- Investigations into the determination of a mixing zone for the Mt Todd discharge for untreated RP1 and RP7 discharge and treated RP3 discharge. *Completed.*
- Ecotoxicological testing to validate the mixing zone. *Not completed.*
- Macroinvertebrate and sediment studies to assess downstream impacts from the mine discharge. *On-going.*
- Investigations into the speciation of metals due to water chemistry at the site. *Completed.*

10.1 Dilution Factors for Wet Season 2014/2015

Ecotoxicological investigations into the toxicity of treated and untreated mine water from several sources were used to calculate a dilution algorithm for use at Mt Todd. The dilution algorithm has been developed to meet 80 percent species protection at SW4 using ecotoxicological testing. The dilutions algorithm to meet the 80 percent species protection is:

- Total Toxicity Units (SO_4, Al, Cu, Ni and Zn): $y = 0.4699x + 10.069$

10.2 Cease Discharge

Discharge will cease upon receipt of laboratory data that shows that the water chemistry at SW4 is greater than or equal to double the SSTVs in Table 8.

10.3 Multiple Discharge Points

Vista Gold does not propose to discharge from multiple discharge points except in the case of unforeseen circumstances when this strategy would be used to reduce the chance of uncontrolled discharges. Vista Gold’s preferred option for managing water volumes on site is by moving water from RP1 and RP7 to RP3 and discharge from RP3 only.

10.4 Risk Assessment for RP3 Discharge at SW4 Mine Water

The risks to the beneficial use and values were assessed for the area of Edith River in the vicinity of surface water monitoring site SW4. The risk assessment identified that copper and pH pose a low risk to the aquatic ecosystem of Edith River at the monitoring site SW4 during discharge events. However, a longer term data set (water quality measured between November 2011 and April 2014) indicates that risk levels are low to nil at SW4. Scores were assigned conservatively, taking into account the most sensitive biota such as microalgae and macroinvertebrates.

10.5 Macroinvertebrate Study

A summary of the 2013/2014 macroinvertebrate study is located in Appendix D. This summarises the report "*Mt Todd Macroinvertebrate & Sediment Monitoring Report: 2013 – 2014 Wet Season*" prepared for Vista Gold by Envirotech Monitoring (undated). Envirotech Monitoring (undated) states that the discharge from the Mt Todd mine site has no significant impact on downstream macroinvertebrate populations.

10.6 Mixing Zone

The results of the mixing zone study indicate that the size of the mixing zone stabilises at higher flow rates, reaching a plateau around the median flow rate.

The rate of transverse mixing in any river is controlled by several site specific factors. The precise transverse mixing characteristics of this reach of the Edith River are unknown. In the absence of site specific mixing data, a realistic range of transverse mixing rate parameters were modelled. The size of the mixing zone results varied from a minimum of around 1000 m to around 3500 m depending on the parameters used and the flow rate at SW4. Therefore, the mixing zone does not extend to sample site SW10 which is 8.7km from SW4 and site SW4 is possibly within the mixing zone.

10.7 Metal Speciation

Appendix J summarises the results obtained for the metal speciation study conducted following the methodology outlined in GHD (2012a). The metal speciation study shows that discharge of treated RP3 water may result in the following bioavailabilities of (0.45 µm filtered) metals at site SW4:

- Cd 86.6 %
- Co 92.1 %
- Cu 16.8 %
- Mn 94.1 %
- Ni 87.3 %
- Zn 91.9 %

11. Recommendations

11.1 Management of Discharge

Apply the SSTVs to SW4 for management of the Mt Todd discharge from RP1, RP3 and RP7. The metal speciation bioavailability will be included in the case of an exceedance of a metal SSTV.

Apply the algorithms for calculating the dilution factor for each RP depending on water chemistry and total toxic units.

11.2 Surface Water Monitoring

Remove chromium and mercury from suite of analytes as chromium is not present in the mine water discharged from site and mercury is below detection limits.

Environmental indicators in Appendix 1 of WDL 178-3 should be monitored on a weekly basis during discharge or once per discharge, depending on the duration of the discharge.

12. Commitments

Commitment 1

A full DTA will be conducted on the RP3 sample after 1GL has been released from RP3 during the 2014/2015 wet season to validate the algorithm and provide support for the dilution factor for RP3 discharge for the water chemistry tested to meet the 80% species protection level at SW4.

Commitment 2

Vista Gold will develop and conduct a mixing zone validation and confirmation study during the 2014/2015 wet season, providing the mine is discharging to the Edith River.

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